

## NOTES

OBSERVATIONS AND AN EXPERIMENT ON SYNCHRONOUS FLOWERING. — Interspecific comparisons of flowering phenology show there is no single pattern for a given climate or vegetative phenology. Although the diversity of patterns ultimately must be accounted for in terms of external selective factors, proximal cues must be defined to comprehend and predict temporal variability and assess its effects. The variations can be investigated by natural and contrived experiments; several factors have been implicated, as reviewed briefly by Opler et al. (*J. Biogeog.* 3:231–236, 1976).

In the tropical deciduous forest at Chamela, Jalisco, México (109°30'N, 105°03'W; av. annual precip. 74.8 cm), a natural experiment in cueing of flowering to rainfall occurred in 1983. Following 18 rainless weeks, and over two weeks before the normal start of the rainy season, hurricane Adolfo passed by offshore bringing 14.9 cm of rainfall on 26 May (17.7 cm in four days). Some species that showed abrupt, generalized flowering in response to this rainfall were the following: *Zanthoxylum fagara* (L.) Sarg. (Rutaceae) began flowering on day two after the rain; *Bernardia spongiosa* McVaugh (Euphorbiaceae) on day three; *Hybanthus mexicanus* Ging. (Violaceae) on day four; *Samyda mexicana* Rose (Flacourtiaceae) and *Tabebuia chrysantha* (Jacq.) Nichols. (Bignoniaceae) on day six; *Erythroxylum havanense* Jacq. (Erythroxylaceae) on day eight; and *E. mexicanum* HBK. on day 11. Between days 10 and 14, several other species showed synchronous, short episodes of flowering. These plants included *Prockia crucis* P. Browne and *Casearia corymbosa* HBK. (Flacourtiaceae), *Hiraea reclinata* Jacq. (sensu lato), *Malpighia* sp. nov. (Malpighiaceae), and three species of *Randia* (Rubiaceae). In these cases, flowering ended within two to eight days, and did not occur again in 1983. In contrast, all typically flower at the start of the rainy season in late June or July.

To confirm the rainfall cue while separating root and bud wetting, to investigate the response to different magnitudes of soil wetting, and to test the effect of extraordinary events on normal flowering, I performed an experiment with *Erythroxylum havanense* (Bullock 1345, 1346, MEXU). This species is an understory shrub up to 200 cm tall; stem basal areas of the sample plants ranged from 0.64 to 19.42 cm<sup>2</sup>. All experimental and control plants were located in one plot of 0.1 ha. On 23 May 1984, I watered the soil within 25 cm radius of each plant, as defined by a 10 cm high circular border. There were three water treatments [1.5 cm of water (n = 12 plants), 4.5 cm (n = 12), and 13.5 cm (n = 4)], in addition to the unwatered controls (n = 12). This year was rainless from 31 January through 10 June. Average soil moisture at 4–8 cm depth adjacent to five control plants was at 9.6 percent of field capacity. In monitoring the plants from 28 May to 3 June, I recorded the presence of buds and the number of flowers, as well as tendencies to leaf expansion.

Control plants and the 1.5 cm group produced no buds. All except two plants in the 4.5 cm and 13.5 cm groups produced both flower buds and leaf buds. On days seven and seven to eight after watering, two plants of the 4.5 cm group flowered; no leaves expanded. On days seven to eight or seven to nine, all plants of the 13.5 cm group flowered; leaves expanded to a variable extent but soon desiccated. Three of these plants flowered maximally on day seven, two on day eight, and one on day nine.

Without developing mature leaves or fruits, 81 percent of the experimental plants that responded to watering flowered again at the start of the rainy season (third week of June), as did all the controls. The possibility of repeated flowering in the other species mentioned above remains to be demonstrated. The delays from strong cue to flowering noted in 1983 may reflect the time for differentiation and/or growth of buds. The developmental cycles (Borchert, *Biotropica* 15:81–89, 1983) are unknown, but only *Bernardia spongiosa* and *Zanthoxylum fagara* have macroscopic resting buds. Multiple rains and flowerings during the dry season, as occur in Costa Rica and Panama (Opler et al., op. cit.; Augspurger, *Ecology of a tropical rain forest*:

seasonal rhythms and long-term changes, p. 133–150, 1982), are not known at Chamela.

For *E. havanense*, a single rain of the middle magnitude may be sufficient for flowering, because rain does not leave small spots surrounded by dry soil. The waterings, however, were more effective than equivalent rain because interception by the forest canopy was avoided. Despite their survival in a comparatively dry climate, with seasonally extreme soil dryness, *E. havanense* and other species at Chamela probably require more rainfall to cue flowering than do similar species in central Panama (Augspurger, op. cit.). Most rains at Chamela are <1 cm (Bullock, Arch. Met. Geoph. Biocl. Ser. B, in press), so threshold moisture is probably approached sporadically in most years, but spatial unevenness in rainfall, canopy, and soil conditions must promote local asynchrony within species.

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*Eschscholzia lemmonii* subsp. *kernensis* (PAPAVERACEAE), A NEW COMBINATION FOR THE TEJON POPPY.—While studying seed coat microsculpturing of *Eschscholzia* (Clark and Jernstedt, Syst. Bot. 3:386–402, 1978), I noticed that a collection labeled *E. caespitosa* Benth. subsp. *kernensis* Munz [6 May 1935, Wolf 6738 (UC)] had seed coats unlike those of other samples of that species. This collection was made later in the same year and at the locality of the type specimen of this subspecies.

Although the seeds were unlike those of *E. caespitosa*, they were very similar to the seeds of *E. lemmonii* Greene (Figs. 1–3). Both have serrate ridge crests and foveate facet cells. Subspecies *kernensis* cells have micropapillae, which are somewhat unusual in *E. lemmonii*, and the ridges are more elevated, giving the seeds a somewhat “burlike” appearance, but they resemble the seeds of *E. lemmonii* more than those of any other species. In contrast, the ridges of seed coats of *E. caespitosa* are lower and the crests are generally uniform. Micropapillae are absent and the facet cells are generally polygonal or obscure, but never foveate.

Although the holotype of subsp. *kernensis* lacks the pubescent and nodding buds that are used to distinguish *E. lemmonii* in identification keys, it agrees in many other respects. Both plants have large turbinate receptacles (Figs. 4, 5), large, deep orange flowers, and stout stems and pedicels, contrasted with the small, obconical receptacles, smaller yellow flowers, smaller fruits, and slender stems and pedicels of *E. caespitosa*.

Twisselmann (Fl. Kern County, CA, 1967) also noticed these similarities, commenting that subsp. *kernensis* was “difficult to distinguish from glabrous forms of *E. lemmonii*.” These glabrous forms, unusual in the field, are common in greenhouse-grown plants, which may also have erect buds. Twisselmann’s account of the range of the subspecies places it between the main range of *E. lemmonii* in the inner south Coast Ranges and its eastern extent in the northern Tehachapi Mountains, in the same grassland habitats. Both the range and the habitat differ sharply from those of *E. caespitosa*, which occupies open sites in oak woodland and chaparral at higher elevations.

Thus, subsp. *kernensis* differs from *E. lemmonii* consistently only by its burlike seeds. Munz apparently made the decision to include it in *E. caespitosa* because of its erect, glabrous buds, but it shares with *E. lemmonii* a number of features unique in the genus. Therefore, I propose the following combination.